1005 Nuclear Cardiology: Attenuation, Correction, and Other Technical Issues

Tuesday, March 18, 1997, Noon–2:00 p.m.
Anaheim Convention Center, Hall E
Presentation Hour: Noon–1:00 p.m.

1005-90 Qualitative and Quantitative Comparison of Sestamibi SPECT Without and With Attenuation Correction for Detection of Coronary Artery Disease in Patients with Large Body Habitus

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Myocardial tomography (SPECT) in patients (pts) with large body habitus and/or large breasts may be compromised by excessive photon attenuation. Accordingly, we evaluated the impact of attenuation correction (AC) on the diagnostic accuracy of SPECT in a cohort of 77 such pts (mean age 61 ± 10 years), who had sestamibi SPECT and coronary angiography within 90 days of each other. There were 44 males (mean weight 230 ± 34 lbs) and 33 females (mean weight 187 ± 44 lbs; bra size, 32C-44DD). Stress/rest sestamibi SPECT was performed using a dual-head SPECT system with simultaneous acquisition of emission and transmission data. Tomograms were reconstructed without and with AC. The minimal regional count-activity in left ventricular (LV) anterior, septal, inferior, lateral and apical segments was calculated using regions of interest (5 × 6 pixels) in the images without and with AC. Overall, 25 pts had normal coronaries and 52 had significant CAD. Sensitivity of SPECT without and with AC was 82%, and 79% (p = ns), respectively. Specificity of SPECT without and with AC was 36%, and 80% (p = 0.002), respectively. In normal pts, AC images yielded higher count-activity than the non-AC images in the LV inferior segment of male subjects (71 ± 13% vs 56 ± 17%, p = 0.030) and in both anterior (83 ± 7% vs 72 ± 12%, p < 0.01) and inferior segments (84 ± 8% vs 76 ± 10%, p < 0.01) of female subjects. Thus, in pts with large body habitus, AC decreases attenuation artifacts thereby improving the specificity of sestamibi SPECT for detection of CAD, without decreasing its sensitivity.

1005-91 Left Main Coronary Disease: Increased Sensitivity With Quantitative Attenuation Corrected SPECT Perfusion Imaging

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The sensitivity of SPECT perfusion imaging is excellent for the detection of coronary heart disease in general. However, presumably because of balanced reductions in myocardial perfusion, SPECT has demonstrated limited sensitivity for the identification of a pattern specific for left main (LM) coronary stenosis. Because normal quantitative perfusion patterns with attenuation corrected (AC) SPECT eliminate the regional biases seen with uncorrected (UC) SPECT, we hypothesize that AC SPECT perfusion imaging should demonstrate increased diagnostic sensitivity for the detection of significant LM coronary stenoses. We studied 20 Pts. (17 men, 13 prior MI) age 66 ± 9 yrs with significant LM stenoses (≥50% stenosis). Significant coronary stenoses were also present in 19 LAD, 13 LCx and 17 RCA territories. Stress Tc-99m sestamibi SPECT and AC were performed as we have previously described. Both AC and UC images were quantified and compared to the appropriate AC and UC normal databases (≥2.5 SD, 3-D MSPECT). UC SPECT identified 34 and AC 51 of the stenosed territories (p < 0.001). There were increases in defect extent scores in the AC images for all coronary territories (44.7 ± 32.9 vs. 34.4 ± 26.6, p = 0.054 LAD; 59.2 ± 34.2 vs. 21.1 ± 26.8, p < 0.001 LCx; 34.4 ± 25.0 vs. 17.7 ± 24.6, p < 0.001 RCA). A large contiguous area of reduced perfusion encompassing > 20% of both the LAD and LCx territories was considered specific for LM stenosis. With AC SPECT perfusion imaging 14/20 Pts. (70%) demonstrated the LM pattern of abnormality whereas only 3 Pts. (15%) did so with UC SPECT (p = 0.001). *Conclusions:* Attenuation corrected SPECT perfusion imaging results in greater defect scores in all coronary territories and significantly increased sensitivity for left main coronary stenoses.

1005-92 Comparison of Exercise and Vasodilator Stress Myocardial Perfusion SPECT Imaging for the Determination of Normalcy Rate and the Effects of Attenuation Correction

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The impact of the method of stress testing on the normalcy rate of myocardial perfusion SPECT and the interaction with attenuation correction (AC) techniques is unknown. Accordingly, we examined 164 pts (81 M, 83 F) with a < 5% likelihood of coronary artery disease; the mean age was 52 ± 12 years. Treadmill exercise testing (Ex) or vasodilator stress testing with either dipyridamole or adenosine (Vaso) was performed in 130 and 34 pts, respectively. Perfusion imaging with and without AC (Vantage™, ADAC Labs, Milpitas, CA) was performed following the injection of Tc-99m sestamibi at peak stress. There were no differences between the groups with respect to age or gender. Image quality was good or excellent in more pts with Ex than with Vaso, for both uncorrected images (91% vs 78%; p < 0.05) and with AC (98% vs. 91%; p < 0.05). The segmental concordance between uncorrected and AC scans in the anterior region was greater for Ex (81%) than with Vaso (65%; p < 0.05). However, the inferior region demonstrated similar concordance between uncorrected and AC images for EX and Vaso, 87% and 85%, respectively (p = n.s.). The normalcy rates for each stress method and the use of AC are displayed below:

	Uncorrected	Corrected
Vaso	74%	79%
Ex	88%	95%
	p < 0.05	p < 0.005

Conclusion: Image quality and normalcy rates are superior with Ex testing compared with Vaso imaging, irrespective of whether or not AC is applied. Additionally, AC improves the normalcy rate when using either Ex or Vaso stress testing. However, regional differences are noted with respect to AC and the method of stress testing utilized.

1005-93 Determinants of Increased Tc-99m Sestamibi Lung Uptake

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The diagnostic and prognostic significance of increased lung uptake in Tl-201 myocardial perfusion scans is well known. However, for Tc-99m sestamibi normal lung/heart count ratios (L/H) and the determinants of increased lung uptake are not well documented. To evaluate the relative importance of resting LV dysfunction and stress induced myocardial ischemia as determinants of Tc-99m sestamibi lung uptake, 4 patient (pt) groups were studied: 1) 76 pts with a < 10% likelihood of coronary disease with normal stress and rest perfusion scans and normal LVEF (normals); 2) 75 pts with prior MI, fixed perfusion defects only, and LVEF ≥35% (MI-I); 3) 67 pts with prior MI, fixed defects only, and LVEF < 35% (MI-II); 4) 24 pts without prior MI, LVEF > 45%, reversible (ischemic) defects, and cath documented CAD (ISCH). Resting LVEFs were calculated from gated SPECT perfusion scans. A L/H ratio was calculated from 30–40 min post-stress anterior planar projection images.

Group	n	LVEF (±1 SD)	L/H (p vs. Normals)
Normals	76	65 ± 9	0.32 ± 0.05
MI-I	75	44 ± 13	0.37 ± 0.08 ($p = 4 \times 10^{-6}$)
MI-II	67	30 ± 15	0.40 ± 0.09 ($p < 10^{-6}$)
ISCH	24	55 ± 8	0.37 ± 0.07 ($p = 2 \times 10^{-4}$)

Thus, both in MI pts with resting dysfunction and no ischemia as well as in pts with normal resting function and stress-induced ischemia the L/H ratio was higher than in normal pts. The L/H ratio was higher in MI-II than MI-I pts (p = 0.03). In all groups L/H ratios for exercise versus pharmacologic stress were nearly identical.

Therefore, both ischemia and the degree of resting LV dysfunction independently contribute to increased sestamibi lung uptake.

1005-94 Left Ventricular Hypertrophy is a Barrier to Using Quantitative Analysis for Myocardial Perfusion SPECT

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To determine the implications of increased septal (S) counts with Tc 99m sestamibi (as previously noted with Thallium SPECT) in patients with LVH,

119 patients with < 10% likelihood of CAD and a visually normal Tc-99m sestamibi perfusion SPECT study were evaluated. Patients were injected with 814–1110 Mbq of MIBI at peak stress with SPECT acquisition at 30 minutes. Polar perfusion plots were assessed for S versus lateral (L) wall uptake and were grouped by 2 independent observers into S ≥ L counts (S group), or L > S counts (L group); or by quantitative analysis of L/S ratios of > or < than 1.01. Comparison of these groups with ventricular septal thickness (VST) by Echo in 37 patients is given below:

	S group	L group	L/S < 1.01	L/S > 1.01
Pt No	20	17	14	23
VST (cm)	1.28 + 0.22	1.07 + 0.14*	1.26 + 0.19	1.10 + 0.2**

*p = 0.001, **p = 0.02

Increased S counts were present in 52% (N = 31) of patients with EKG-LVH versus 22% (N = 88) without LVH (p = 0.003) and in 61% of patients with VST > 1.1 cm (N = 23) versus 21% in those with VST < 1.1 cm (N = 14) (p = 0.04). Quantitative analysis demonstrated defects > 2 standard deviations of normal limits in 22% (8/36) in the S group versus 2% (2/83) in the L group (p = 0.001). Defects in the S group were mostly in the lateral wall (6/8).

Conclusions: Underlying EKG and Echo LVH are associated with increased septal counts in hypertensive patients with Tc-99m sestamibi SPECT. There is a high frequency of false positive lateral wall defects by quantitative analysis among patients with a low likelihood of CAD and visually normal scans, suggesting a limitation of this technique.

1005-95 Maximum Likelihood Restoration of Artifactually Reduced Myocardial Uptake Due to Intense Hepatobiliary Activity

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We previously documented false inferior wall count reduction due to intense hepatobiliary activity in resting Tc-99m sestamibi myocardial perfusion tomograms performed sooner than 30 min post injection, caused by negative spatial frequency components of standard filtered backprojection (FB) reconstruction. To study whether prevalence of this artifact can be reduced through alternative 30-iteration maximum likelihood (ML) reconstruction, both 15 min and 30 min resting sestamibi data were processed along with stress studies for 30 patients (pts) by FB and by ML. Reoriented paired short-axis slices from both reconstruction techniques were read visually, and polar perfusion maps were constructed from them for quantitation. Visually, 9 (30%) pts had inferior wall artifact, for whom the difference between 30 min and 15 min defect-to-normal ratios (ΔD:N) was 11 ± 3% compared to 2 ± 6% in remaining pts. Defining ΔD:N = 10% as constituting artifact by quantitation, the number (percent) of pts exhibiting artifact was 9 (30%) by FB and 4 (13%) by ML. Visually, artifact prevalence reduced to 5 (16%). Visual and quantitative assessments of artifacts were closely associated (χ^2 = 10.95; p = 0.0009). By visual analysis, 7/9 (78%) artifacts improved with ML while 2/30 pts (7%) worsened. We conclude that ML helped reduce artifact frequency compared to FB, but that ML alone did not entirely eliminate the phenomenon. Attenuation compensation along with ML may be required to completely resolve this artifact.

1005-96 Lack of Gender Differences in Tc-99m Sestamibi Tomographic Myocardial Perfusion Images Obtained With Attenuation Correction and Enhanced Acquisition Methods

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Soft tissue artifacts reduce the accuracy of tomographic perfusion imaging (SPECT). Attenuation correction (AC) and new acquisition and reconstruction procedures may improve the overall accuracy of SPECT imaging. Rest Tc-99m sestamibi SPECT studies were analyzed in 39 patients (20 women) with a low likelihood (< 5%) of coronary disease, using a 3-headed Picker 3000xp camera with a Gad-153 source for simultaneous AC during a 360º continuous acquisition. Images were reconstructed with an expectation maximization - minimization likelihood algorithm. In each patient, 8 matched regions of interest (ROI) on 3 short axis slices (LV apex, mid-cavity, and base) were analyzed for regional differences. AC and non-AC data sets were compared using one way ANOVA and regions were compared with the student t-test. *Results:* In the 936 ROIs analyzed with and without AT, the standard deviation (SD) from the mean for the AC regions was lower than non-AC regions (9.9% vs 12.5%, p = 0.02). The SD's were similar in men and women with and without AC (men AC 9.9%, non-AC 13.0; women AC 10.2%, non-AC 11.9%). In the non-AC images, over 90% of the 121 (12.9%) regions which were ≤ 85% of the mean were located in the inferior and septal regions at the LV base with an average value of 0.76 ± 0.05 and occurred with similar frequency in men and women (91% vs 83%; p = NS). AC significantly improved these areas (men 0.78 to 0.87; women 0.75 to 0.86, p < 0.001). No significant reduction in anterior counts was present in either women or men. Of the ROIs ≥ 1.15, 73% were in the anterolateral regions of the mid-cavity and apex and also showed improved uniformity with AC (men 1.18 to 1.09, women 1.14 to 1.10, p < 0.001). *Conclusion:* AC significantly improves image uniformity. In both men and women there is a similar pattern of regional count variation in AC and non-AC images suggesting a reduced effect of tissue attenuation with enhanced acquisition and reconstruction methods.

1006 Platelet Function and Thrombosis

Tuesday, March 18, 1997, Noon–2:00 p.m.
Anaheim Convention Center, Hall E
Presentation Hour: 1:00 p.m.–2:00 p.m.

1006-155 Hyperglycemia Impairs The Ability of Human platelets to mediate Vasodilation via Protein Kinase C-Dependent Pathway

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Platelets from patients with diabetes mellitus (DM-plts) have impaired ability to cause vasodilation. Exposure to high glucose concentration (HG) in vitro causes same platelet abnormality in normal human platelets (NL-plts). HG in vitro has been reported to affect protein-kinase C (PKC) activity. Thus, we tested whether DM and HG impair the ability of human plts to cause vasodilation via PKC-dependent pathway. *Methods:* Changes in arterial diameter (CIAD) were imaged, digitized and analyzed during perfusion of thrombin activated platelets through preconstricted normal rabbit carotid arteries. *Results:* As previously observed, activated DM-plts (n = 6) failed to cause vasodilation: −2.5 ± 1% CIAD (mean ± SE). However, same diabetic platelets, treated for 2 h with 50 nM Calpostin-C (Cal-C), a PKC inhibitor, produced normal vasodilation; 29 ± 5%, p > 0.01 vs. untreated. After NL-plts (n = 6) had been incubated for 4 h in either normal Tyrode's buffer (118 mg% glucose) or Tyrode's containing 300 mg% glucose (GLU-plts), they produced 28 ± 2% vs. 1 ± 1% CIAD, respectively (p < 0.01). However, when treated with 50 nM Cal-C for 2 h, NL-plts and GLU-plts both produced normal vasodilation: 27 ± 3% and 23 ± 2% CIAD, p = NS. When NL-plts were "primed" with 80 nM PMA (PKC activator) for 15 minutes (washed off before vessel perfusion), they lost their ability to mediate vasorelaxation: −2.4 ± 1% (+PMA) vs. 32 ± 2% (−PMA) CIAD (n = 8, p < 0.01), very similar to the effect of high glucose concentration. Dimethyl thiourea (25 mM), which restores the ability of DM-plts and GLU-plts to cause vasodilation, also restored platelet-mediated vasodilation by PMA treated platelets. *Conclusions:* The inability of DM-plts and GLU-plts to cause vasodilation appears to be mediated by activation of a PKC dependent pathway.

1006-156 Platelet Inhibitory Effect of Feeding Grape Juice But Not Orange or Grapefruit Juice for Seven Days in Monkeys

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Epidemiological studies show an inverse correlation between the intake of dietary flavonoids (Fs) and death from coronary artery disease (CAD), explained in part by the antioxidation of LDL cholesterol and reduced platelet aggregation (PA). PA contributes to the development of atherosclerosis and also acute platelet thrombus formation (APTF). Fs inhibit PA by blocking Thromboxane A_2 production and raising platelet cyclic AMP. Grape juice (GJ), 10 ml/kg, by stomach tube abolished APTF and cyclic flow reductions (CFRs) in stenosed and damaged dog coronary arteries (Folts cyclic flow model). Aspirin, 5–10 mg/kg abolishes APTF and CFRs but they are renewed with epinephrine (Epi), 0.2 μg/kg/min IV. There were no CFRs produced in dogs given Epi after GJ. GJ, orange juice (OJ) and grapefruit juice (GFJ) contain different Fs. Fs bind to platelet cell membranes in vitro and may have a tissue loading effect when fed over time in vivo. To test this we fed 5 ml/kg, half the minimum effective dose, of GJ, then OJ, and finally GFJ randomly to 5 rhesus monkeys for 7 days with 7 days washout between feedings. A control blood sample was obtained prior to feeding and after 7 days of feeding each juice. Ex vivo PA (whole blood aggregometer) was decreased by 49 ± 11% (p < 0.01) in response to collagen, after 7 days of GJ. Feeding OJ or GFJ decreased PA by 19 ± 9 (ns) and 14 ± 11% (ns). Thus, the Fs in GJ are more potent PA inhibitors than those in OJ or GFJ and better than aspirin.